IEAGHG Information Paper: 2016-IP4; Developments in Renewable Methanol Production

Methanol is conventionally manufactured from synthesis gas which is a mixture of carbon monoxide and hydrogen. The feedstock, over the last 40 or more years, has been typically oil or natural gas. In China coal is also used as the feedstock. Increasingly, there is interest in biomass as a feedstock for bio-methanol, which could become central to the development of bio refineries as an intermediate in the conversion of biomass to useful products[1].

The current largest use for methanol is as a feedstock for the plastics industry. Methanol is now the principal source for the manufacture of ethanoic acid.

Until recently only a small amount of methanol was used directly as a fuel in cars, this use is now increasing rapidly. In China petrol is mixed with methanol (15%) without the need for engines to be redesigned. With some redesigning, more methanol (up to 85%) can be used. The advantage for China is that the methanol can be produced from both coal and biomass via synthesis gas. This emphasis of using methanol as a fuel is reflected in the global production figures for methanol. Thus worldwide, use of methanol as a fuel now accounts for 14% (about 9 million tonnes a year) but is expected to increase to 16% of an increased total production of 92 million tonnes (about 15 million tonnes) by 2016

In a recent development a company called Carbon Recycling International (CRI)[2] has constructed the first CO_2 to methanol plant based on a DAC type process in Iceland. The produces 4,000 tonnes of methanol per year. The plant takes advantage of geothermal energy (the steam is also rich in CO_2) for both heat and electricity production. The CRI process then electrolytically splits water to produce hydrogen which is combined with the CO_2 to produce methanol. The CRI process uses solid copper and zinc oxide catalysts to reduce the water and operates at 250^0c and 100 atmosphere pressure.

CRI's George Olah Renewable methanol plant in Reykavik, Iceland © Carbon Recycling International, 2007-2012

The plant, was completed at the end of 2012. CRI plans to expand the plant to produce more than 10,000 tonnes a year and to reclaim 5.5 thousand tonnes of carbon dioxide a year that would otherwise be emitted from the atmosphere. The sole by-product is oxygen. The methanol is blended

[1] http://www.essentialchemicalindustry.org/chemicals/methanol.html
[2] http://www.carbonrecycling.is/

with gasoline and sold at gasoline stations in Iceland and abroad. The company claims that production of methanol by harnessing Iceland's geothermal energy is reproducible in many similar locations around the world.

CRI has agreements with Methanex[3] and Perstorp[4] to use the methanol to make bio-diesel. In 2015, CRI agreed a co-operation arrangement with the Chinese Carmaker Geely (owners of the Volvo brand) that will see them invest $45 million in CRI. As part of this agreement six Emgrand EC7[5] methanol vehicles, which utilize a pure methanol 1.8L engine developed by Geely Auto, will enter a fleet trial in Iceland. The vehicles have been previously tried and tested throughout China in various fleets in Shanghai City, Shanxi and Guizhou provinces[6].

In addition, the Dutch Company, BioMCN is the world's largest producer of second-generation biofuels with an annual production capacity of 250 million liters. BioMCN's patented process takes the crude glycerin left over from processing animal fat and vegetable oil and converts it into bio-methanol[7]. The bio methanol is used as a feedstock for bio-MTBE, biodiesel and biohydrogen, as well as methanol fuel for transportation.

In Summary

This briefing note highlights two novel developments to produce a globally traded commodity like methanol from non-fossil fuel based process routes. The CRI process uses a renewable energy source, geothermal energy, the emissions saved are non-anthropogenic as their source is magmatic CO_2. But is such a renewable commodity can displace fossil based methanol production then there could be an emissions saving but this would need to be looked at from a life cycle product basis. The second uses a waste product to produce bio-methanol. The global availability of glycerine would need to be considered to assess the global potential to displace fossil based methanol production with new opportunities such as this. But using the by-product of biodiesel production to create a feedstock that could displace biodiesel i.e. bio methanol suggests an early niche option not a long term solution. However the innovation we are seeing is interesting in itself.

The main driver here is that methanol can be used in automotive engines very similar to those currently on the market, as well as being able to be stored and transported in much the same way that diesel and gasoline are today. If the methanol can be produced from renewable routes it could have advantages such has; reduced fossil fuel use and greenhouse emissions from production, but these need to be fully assessed through an LCA process.

The policy driver in Europe of course is European Union's Renewable Energy Directive (RED) which includes several fuels, including bio-MTBE, bio-DME, bio-hydrogen, and synthetic biofuels, which can be made from bio-methanol.

This area of fossil fuel substitution for chemical production and the impacts on CO_2 mitigation is one that IEAGHG needs to consider in the future. At the moment the amount of CCU products is limited

[3] Methanex is the largest global supplier of methanol, https://www.methanex.com/

[4] The Perstorp Group is a world leader in several sectors of the specialty chemicals market for a wide variety of industries and applications. https://www.perstorp.com/

[5] The Emgrand EC7 is a large family car produced by the Emgrand division of the Chinese automaker Geely. see https://en.wikipedia.org/wiki/Emgrand_EC7

[6] http://www.carbonrecycling.is/index.php?option=com_content&view=article&id=86%3Afirst-geely-auto-methanol-vehicles-in-europe-arrive-in-iceland&catid=2&Itemid=6&lang=en

[7] http://www.methanol.org/getattachment/Environment/Renewable-Methanol/BioMCN-and-Bio-Methanol.pdf.aspx

and their mitigation potential is questionable at best. IEAGHG has a study agreed by members that could begin to look at some of these issues where products like methanol (and its derivatives) could displace petroleum products in the future.

IEAGHG also has a study underway that is looking at the integration of CCS/CCUS into hydrogen production facilities and how this might impact the economics of conventional fossil based methanol production.

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